

Table 2. Summary Screening of Remedial Technologies and Process Options by AOPC for the Portland Harbor Superfund Site.

General Response Action	Remedial Technology	Process Options	Description	Screening Comments ¹
No Action	None	Not Applicable	No Action	Required for consideration in all AOPCs by NCP
Institutional Controls	Governmental Controls	Commercial Fishing Bans	Commercial fishing bans are government controls that ban commercial fishing for specific species or sizes of fish or shellfish and are established by state departments of health or other governmental entities.	Retained for all AOPCs. ²
		Waterway Use Restrictions or Regulated Navigation Areas	Provides notice to navigation to prevent damage to caps, in-situ treatment, EMNR, etc.	Retained for all AOPCs. ²
	Proprietary Controls	Deed restrictions, easements, and covenants Land Use/Access Restrictions	Restrictions, such as deed restrictions, easements, and covenants, placed in property related documents or physical barriers, such as fences.	Retained for all AOPCs. ²
		Structure Maintenance Agreements	Requirements to conduct maintenance of in-water structures where caps are co-located in river.	Retained for all AOPCs.
	Enforcement and Permit Tools	Permit Processes or Provisions of Administrative Orders or Consent Decrees	Restrictions implemented through agencies who permit construction activities in the aquatic environment or placed by EPA on the potentially responsible party through orders or consent decrees. Legal tools, such as administrative orders, permits, and Consent Decrees (CDs), that limit certain site activities or require the performance of specific activities (e.g., to monitor and report on an IC's effectiveness). They may be issued unilaterally or negotiated.	Retained for all AOPCs. ²

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	Informational devices	Fish Consumption Advisories	Fish consumption advisories provide information to the public from state departments of health or other governmental entities on acceptable fish consumption rates and fish preparation techniques.	Retained for all AOPCs. ²
Natural Attenuation- Monitored Natural Recovery	Monitored Natural Recovery- Physical Transport	Monitored Natural Recovery- Desorption, dispersion, diffusion, dilution, volatilization, resuspension, and transport.	Monitored Natural Recovery through physical (e.g., burial), chemical (e.g., photolysis) and biological (e.g., biological degradation) processes. Natural ongoing processes that reduce toxicity through transformation or reduce bioavailability through increased sorption, destruction, or reduction of bioavailability or toxicity of contaminants in sediment	Retained for all AOPCs.
	Chemical and Biological Degradation	Dechlorination (aerobic and anaerobic), biodegradation	Natural ongoing processes that dechlorinate or degrade chemical toxicity through biological processes.	Retained for all AOPCs.
	Physical Burial Process	Sedimentation	Reduce exposure through natural burial or mixing-in-place.	Retained for all AOPCs.
Enhanced Monitored Recovery	Enhanced Burial/Dilution	Enhanced Monitored Natural Recovery (EMNR)/Thin Layer Placement Thin Layer Cap	Enhancement of MNR (e.g., burial) through placement of a thin layer of material (e.g., 6" of sand).	Retained for all AOPCs.
Containment in Place	Capping	Engineered Cap Conventional Sand Cap	Physical isolation of contaminants with sand cover and other structural elements (such as armor) as necessary to keep the cap stable.	Retained for all AOPCs.
		Conventional Sand/Clay Cap	Physical isolation of contaminants with Sand/Clay cover.	Retained for all AOPCs.
		Armored Cap	Physical isolation of contaminants with sand cover and other structural elements (such as armor) as necessary to keep the cap stable.	Retained for all AOPCs.

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		Composite Cap (e.g., HDPE, Geotextile)	Physical and/or chemical isolation of contaminants by layering heavy-duty composite protection mat designed for placement over sediments to guard against damage by erosion, scouring, heavy equipment or other forces.	Retained for all AOPCs.
		Active Capping (Engineered Cap with Active Layer) Reactive Cap	Placement of active capping layers such as activated carbon or organoclay to reduce contaminant flux through capping materials. Same technology as described above for "Active Capping".	Retained for all AOPCs.
		Engineered or Active Caps with Habitat Layers	Physical isolation of contaminants with engineered cap; habitat layer at surface to enhance reestablishment of benthic community and/or provide mitigation for remedy impacts.	Retained for all AOPCs.
In-Situ Treatment	Biological/Chemical	Enhanced Slurry Bioremediation	Addition of nutrients and other amendments to enhance bioremediation	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Phytoremediation	Use of plants to remediate contaminated sediments	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Aerobic Biodegradation	Bioremediation uses microorganisms to degrade organic contaminants in soil, sludge, and solids in situ. The microorganisms break down contaminants by using them as a food source or cometabolizing them with a food source. Aerobic processes require an oxygen source, and the end products typically are carbon dioxide and water.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.

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	Chemical	Anaerobic Biodegradation	Bioremediation uses microorganisms to degrade organic contaminants in soil, sludge, and solids either excavated or in situ. The microorganisms break down contaminants by using them as a food source or cometabolizing them with a food source. Anaerobic processes are conducted in the absence of oxygen, and the end products can include methane, hydrogen gas, sulfide, elemental sulfur, and dinitrogen gas.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Imbiber Beads	Spherical plastic particles that absorb a very broad cross section of the organic chemical spectrum.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Chemical Slurry Oxidation	Application of chemical oxidants to remediate contaminated sediments. Chemical oxidation typically involves reduction/oxidation (redox) reactions that chemically convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, or inert.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
	Physical-Extractive Processes	Oxidation	Chemical oxidation typically involves reduction/oxidation (redox) reactions that chemically convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, or inert.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Sediment Flushing	In situ flushing is defined as the injection or infiltration of an aqueous solution into a zone of contaminated soil/groundwater, followed by downgradient extraction of groundwater and elutriate (flushing solution mixed with the contaminants) and aboveground treatment and discharge or re-injection.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.

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	Contaminant Sequestration-Physical - Immobilization	In-Situ Solidification/Stabilization	The addition of reagents that immobilize and/or bind contaminants to the sediment in a solid matrix or chemically stable form.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		In-Situ Vitrification	Use of strong electrical current to heat sediment to temperatures above 2400°F to fuse it into a glassy solid.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Electrochemical Remediation-Oxidation	Technology for degrade organic contaminants in situ by applying an alternating current across electrodes placed in the subsurface to create redox reactions.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Direct Amendment Granulated Activated Carbon (GAC)	Carbon (activated carbon or other carbon materials) to reduce bioavailability of organic contaminants, other amendments to treat a wider range of COCs.	Retained for all AOPCs.
		Ground Freezing	The ground freezing process converts in situ pore water to ice through the circulation of a chilled liquid via a system of small-diameter pipes placed in drilled holes. The ice acts to fuse the soil or rock particles together, creating a frozen mass of improved compressive strength and impermeability. Brine is the typical cooling agent, although liquid nitrogen can be used in emergency situations or where the freeze is only required to be maintained for a few days.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Enhanced Cap Materials-	Placement of active capping layers such as activated carbon or organoclay to reduce contaminant flux through capping materials. Same technology as described above for "Active Capping".	Retained for all AOPCs.

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Removal	Dredging	Mechanical Dredging, Water-Based	Use of clamshell, closed, hydraulic, or other buckets to remove contaminated sediment from a barge or other vessels.	Retained for all AOPCs.
		Mechanical Dredging, Land-Based Dry Excavation	Use of excavators, buckets, etc. deployed from land based equipment. Can be "in the wet" or "in the dry" in combination with sheet piles, coffer dams, or other measures to remove water.	Retained for all AOPCs for consideration in nearshore areas.
		Hydraulic Dredging	Use of hydraulic dredges (e.g., cutterhead, horizontal auger, plain suction, pneumatic, or specialty dredges) with various cutter and suction heads to remove contaminated sediments from the environment in a slurry phase. Requires extensive dewatering facilities.	Retained for all AOPCs.
		Small Scale Dredge Equipment	Diver assisted or hand held hydraulic dredging, Mud Cat, and similar small scale removal methods.	Retained for all AOPCs for consideration around structures.
Confinement	Commercial Landfill	Hillsboro	A disposal site where solid waste is buried between layers of dirt and other materials in such a way as to reduce contamination of the surrounding land. Modern landfills are often lined with layers of absorbent material and sheets of plastic to keep pollutants from leaking into the soil and water.	Retained for all AOPCs.
		Northern Wasco County		Retained for all AOPCs.
		Roosevelt Regional		Retained for all AOPCs.
		Columbia Ridge (Subtitle D)		Retained for all AOPCs.
		Chem Waste (Subtitle C)		Retained for consideration for RCRA contaminated waste.
	Onsite Upland Landfill	No likely candidate property.	A disposal site where solid waste is buried between layers of dirt and other materials in such a way as to reduce contamination of the surrounding land. Modern landfills are often lined with layers of absorbent material and sheets of plastic to keep pollutants from leaking into the soil and water.	Screened out for all AOPCs due to lack of location and floodplain issues.

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General Response Action	Remedial Technology	Process Options	Description	Screening Comments ¹
	Confined Aquatic Disposal (CAD)	Willamette River (RM 4/5)	Holes dug in open water or low spots in the aquatic environment that are filled, then covered with clean material (e.g., cap).	Retained for all AOPCs.
		Willamette River (RM 9)		Retained for all AOPCs.
		Swan Island Lagoon		Retained for AOPC 17.
		Columbia River (RM 102.5)		Retained for all AOPCs.
		Ross Island		Retained for all AOPCs.
	Confined Disposal Facility (CDF)	Terminal 4 Slip 1	A facility built specifically for the disposal of dredged sediment.	Retained for all AOPCs.
		Swan Island Lagoon		Retained for all AOPCs.
		Arkema		Retained for AOPC 14.
Ex-Situ Treatment	Pre-Treatment-Physical	In-barge Dewatering	Dewatering through passive dewatering on barge	Retained for all AOPCs. ³
		Lagoon Dewatering	Dewatering through placement in lagoon. Water discharge takes place on particles have settled out.	Retained for all AOPCs. ³
		Geotextile Tube Dewatering	Geotextile tubes allow water to migrate through membrane retaining sediments	Retained for all AOPCs. ³
		Mechanical Dewatering	Use of filter presses or other similar equipment	Retained for all AOPCs. ³
		Reagent Dewatering	Use of reagents to chemically absorb excess water.	Retained for all AOPCs. ³
		Particle Separation	Separation of sandier sediments with less contamination for beneficial reuse.	Screened-out for all AOPCs. Retained for all AOPCs.
		Blending-	Blending of contaminated sediment with other material for beneficial reuse.	Screened-out for all AOPCs.
		Cement Solidification/Stabilization	Solidification/stabilization of contaminated sediments through addition of Portland cement.	Retained for select AOPCs 1, 3, 9U, 11, 12, 13, 15, 16, 17S, 18, 19, 21, 22, 24, 25.
		Sorbent Clay Solidification/Stabilization	Solidification/stabilization of contaminated sediments through addition of sorbent clays such as bentonite.	Retained for select AOPCs 1, 3, 9U, 11, 12, 13, 15, 16, 17S, 18, 19, 21, 22, 24, 25.

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		Asphalt Emulsion	Treatment of contaminated sediments with asphalt emulsion to remove water and bind contaminants.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Solar Detoxification	Technology for using concentrated sunlight to break down and destroy hazardous waste.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
	Biological Methods	Land Treatment	Large scale land treatment to reduce contaminant concentrations through biological processes.	Retained for select AOPCs 16, 21, and 22.
		Composting	Large scale land treatment to reduce contaminant concentrations through composting.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³ Retained for all AOPCs.
		Biopiles	Large scale land treatment to reduce contaminant concentrations through biopiles	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Fungal Biodegradation	Large scale land treatment to reduce contaminant concentrations through fungal plants.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Slurry-phase Treatment	Biological treatment in a slurry phase.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Enhanced Biodegradation	Acceleration of the natural bioremediation processes by providing oxygen, reducing agents, nutrients, and degrading microorganisms.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
	Chemical	Acid Extraction	Use of acids to extract contaminants from dredged sediments.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Solvent Extraction	Use of solvents to extract contaminants from dredged sediments.	Retained for consideration for sediments containing total PCBs greater than 50 ppm.

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	Physical/Chemical	Sediment Washing	Wash sediments with water to remove contaminants.	Screened out for all AOPCs. Retained for consideration in all areas with high volumes of removed sediments containing organic contaminants and coarse grain material.
		Chemical Extraction	Use chemical extractant to remove contaminants from sediment.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Chemical Oxidation/Reduction	Degradation of contaminants through redox or slurry oxidation. Reducing/oxidizing agents are used to chemically convert toxic contaminants in excavated waste materials to less toxic compounds that are more stable, less mobile, and/or inert. Commonly used reducing/oxidizing agents are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Dehalogenation	Removal of halogens (e.g., chlorine) through chemical dehalogenation reactions.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		Slurry Oxidation	Involves mixing an oxidizing agent with contaminated sediments. The oxidation process mineralizes most organic compounds to carbon dioxide, water, and salts. Typical oxidizing agents include: Sodium hypochlorite (or other hypochlorite compounds), Hydrogen peroxide, Chlorine, Chlorine dioxide, Potassium permanganate, and Ozone.	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.

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	Thermal Methods	Radiolytic Dechlorination	Radiolytic (electron beam) and photolytic (ultraviolet, UV) dechlorination of polychlorinated biphenyls (PCBs).	Screened out for all AOPCs due to likely limited effectiveness and implementability issues.
		Incineration	Thermal treatment through incineration.	Screened out for all AOPCs. Retained for RCRA-listed waste prior to land disposal of treated residuals
		Pyrolysis	Thermal treatment through pyrolysis. Chemical decomposition induced in organic materials by heat in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 430°C (800°F).	Screened out for all AOPCs due to likely limited effectiveness and implementability issues. ³
		High Temperature Thermal Desorption	Heating of contaminated sediment to drive off and capture contaminants. Involves the application of heat (320 to 560°C or 600 to 1,000°F) to excavated wastes to volatilize organic contaminants and water. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a treatment system, such as a thermal oxidation or recovery unit.	Screened out for all AOPCs. Retained for consideration for sediments containing total PCBs greater than 50 ppm.
		Low Temperature Thermal Desorption	Involves the application of heat (90 to 320°C or 200 to 600°F) to excavated wastes to volatilize organic contaminants and water. Typically, a carrier gas or vacuum system transports the volatilized water and organics to a treatment system, such as a thermal oxidation or recovery unit.	Retained for all AOPCs.

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		High Pressure Oxidation	This category includes two related technologies: wet air oxidation and supercritical water oxidation. Both processes use the combination of high temperature and pressure to break down organic compounds.	Screened out for all AOPCs.
		Vitrification	Application of electrical current to heat contaminated sediments to high temperatures.	Screened out for all AOPCs.

1 Rationale for screening decision provided in the Alternatives Screening Presentation dated April 6, 2011 unless otherwise noted.

2 Rationale for screening decision provided in materials on Institutional Controls supplemental to the Alternatives Screening Presentation dated April 6, 2011.

3 Rationale for screening decision provided in the Treatment Technology Evaluation Tools Memorandum dated March 15, 2011 or previous documents cited there.